New Problems of Food Safety

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The safety of food has been of concern to man from the very earliest times. Whether through instinct or intelligence, by trial and probably sometimes fatal error, forgotten benefactors of the race must have learned to eat substances that would not harm them; and they must have conveyed that knowledge to others, else we might not be here to speculate in this vein. Though probably accumulating slowly, a wealth of information regarding food safety had developed by the dawn of recorded history; witness, dietary customs and taboos reflected in the most ancient of ecclesiastic law.

With a few exceptions, those substances, natural or unnatural, that result in immediate acute harm are not the cause of food safety problems in modern civilization. Rather, it is the insidious hazard of chronic toxicity that is the most serious concern today, a hazard that demands a far more subtle and searching approach.

Current food safety problems arise in large part as a result of technological progress in food production, processing, and distribution. To meet economic pressures, the agriculturalist, that traditional conservative, must now intensively apply many types of advanced technology. His partner in "agribusiness," the food processor, is, of course, no novice in this field. Their joint accomplishment during the past several decades is abundantly apparent in the ample quantity, high quality, and appetizing variety of foodstuffs available to the American public. Nonetheless, in the very nature of the progress that has brought these benefits, hazard to food safety is inherent. That fact does not necessarily mean that harm is actual or even imminent; but it does mean that need for gauging the existence and immediacy of danger is genuine and pressing.

One important group of current food safety problems stems from employment, in food production, of a long and lengthening series of chemical adjuvants—insecticides and insect repellants, fungicides, herbicides, defoliants, plant growth regulants, animal growth stimulants and medicaments, crop protectants and fumigants. These substances are commonly of complex, sometimes uncertain, and even occasionally unknown chemical identity. One of the problems in this area is to ascertain whether food exposed to them is contaminated and to gauge the degree of contamination.

In processing, food may receive preservatives, antioxidants, colors, bleaches, flavors, coatings, drying agents, moistening agents, thickening agents, sequestering agents, "aging" agents, stabilizers, emulsifiers, neutralizers, acidifiers, sweeteners—in short, retainers, modifiers, and inhibitors of virtually every property natural food may exhibit. (But we don't mean to imply any opposition whatever to genuine improvement per se.)

Associated with food production and processing are new equipment cleaners, sanitizers, and lubricants, new surfacing materials, and new alloys composing the equipment itself, any of which may get into the product.

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Today's food packages, incorporating new plastics, enamels, films, and tissues, with their own plasticizers, antioxidants, catalysts, impregnants, coatings, and the like, are still another potential source of additives to the very food which these materials are intended to protect from contamination.

Some anonymous philosopher has said that he who can get a corner on a food production adjuvant, used in even relatively minute quantity in this multibillion-dollar commerce, has his fortune made. Indeed, the benefit to their sponsors seems likely to prove the only net advantage of some proposed food additives. But we need not consider those wholly undeserving suppliants for entry into our food supply. Nor need we concern ourselves with most of those natural substances that have been tested through long years of use. Entirely aside from these, the novel and substantially artificial food additives that may be conceded some real functional merit are so many that an informed observer has no doubt whatever that they present food safety uncertainties. It is estimated that some 25,000 chemical additives have been considered for use in food since 1940 (see chart).

Safeguarding the Physically Subnormal

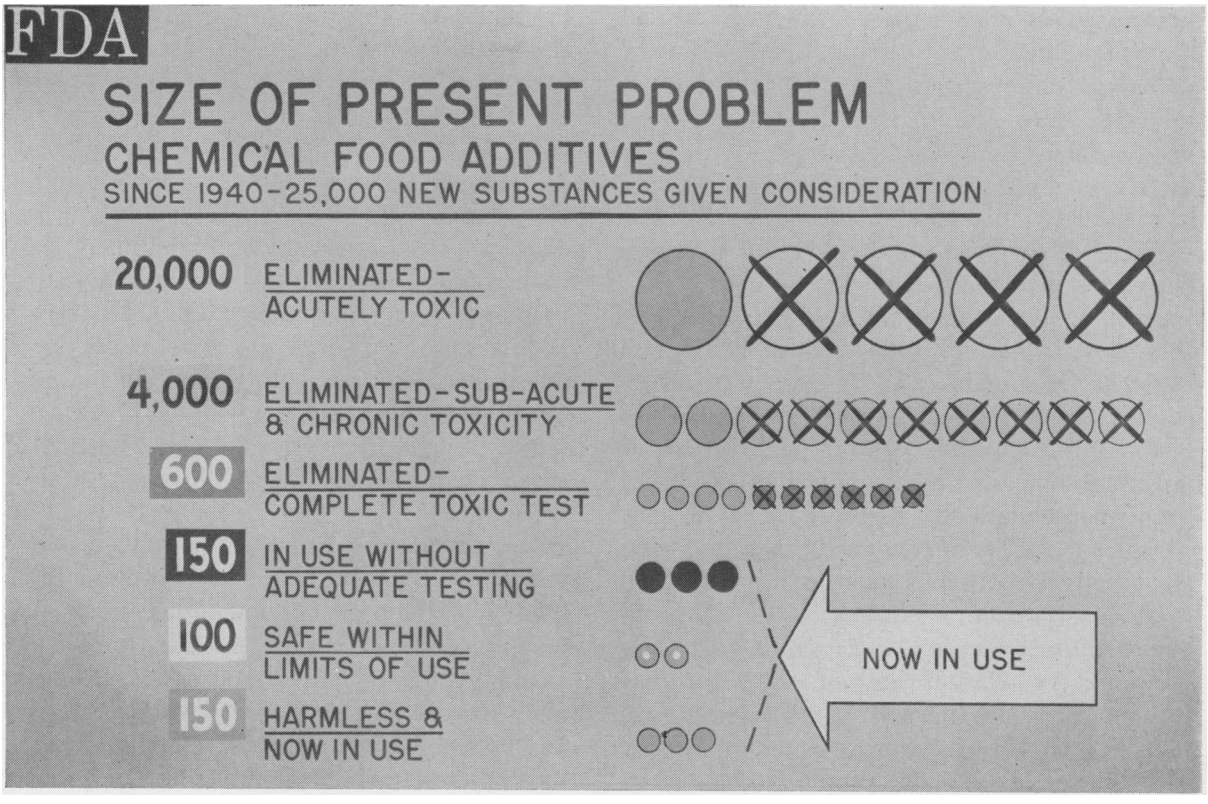
Set aside for the moment (but don't forget) the fact that there is a large and growing backlog of study to ascertain food contamination from its production and processing adjuvants and to evaluate the toxicity of the adjuvants to normal adults in good health. Aside from that aspect, it remains generally to be determined what their effect may be on persons in subnormal physical condition.

No person is expendable within the meaning of the Federal Food, Drug, and Cosmetic Act. In a very significant decision (233 U. S. 399), the Supreme Court said that the food at issue "may be consumed . . . by the strong and the weak, the old and the young, the well and the sick; and it is intended that if . . . because of any added poisonous or other deleterious ingredient, [it] may possibly injure the health of any of these, it shall come within the ban of the statute."

Orthodox techniques and procedures of toxicology are not well suited to establishing that a substance is safe for persons with varied types of physical impairments. Pharmacological investigation ordinarily proceeds on the basis of observable effects produced by administering the test substance to cloistered, well-fed and well-cared for, normal laboratory animals. However appropriately the findings so obtained may be interpreted in application to the human norm, there may be valid reservations to translating them into terms of effect on health of unusually susceptible individuals. The Supreme Court decision cited allows those responsible for safeguarding the food supply scant liberty to indulge in the educated guess or the calculated risk.

This consideration comes to a particularly critical focus with respect to milk, which may represent the principal component of the diet of babies, old folks, and invalids. The law authorizes establishment of tolerances for residues of useful pesticides "to the extent necessary to protect the public health." One may not assume that pesticides don't get into milk merely because no one purposefully puts them there. Pesticides are useful in production of feed and fodder crops, on dairy premises, and on lactating animals themselves. Some of them, particularly some halogenated hydrocarbons, when ingested or absorbed through the skin of animals, are known to appear in the milk—sometimes unchanged, sometimes modified by reaction within the animal system. One must consider whether residues of other pesticides so employed may perhaps have escaped detection in milk because the parent compound metabolizes to another toxicant unresponsive to methods of analysis so far employed. Under these circumstances there may be only an obscure basis, generally, on which to set tolerances for residues of pesticides used in connection with milk production.

The possibility exists, of course, that use of a pesticide would not contribute contamination to milk, but this raises other quite practical questions. For example, how does one ascertain that no residue whatever is present in a food? By analysis? That tool of science is designed to determine the presence of a substance, not its absence. It is capable of demonstrating some minimum concentration of a specific entity, such minimum being fixed by the limit of



delicacy of the analytical procedure. It cannot show, at least not directly, whether a lesser concentration exists or whether some substance unresponsive to the method is present. Before an adequate method of analysis can be selected or devised, a decision must be reached as to what concentration is of minimum significance, a decision that is practically equivalent to establishing the threshold of contamination. So one may be right back at the starting point. A gauge of harmfulness of the pesticide to the more susceptible segments of the population is ordinarily basic to justification of use of any pesticide, whether it is directly or indirectly associated with dairy practice.

The Biochemical Approach

We cannot offer solutions to these problems, but we can suggest that an improved understanding of reactions that food additives may undergo in the animal (and human) system would contribute substantially. Were it possible to predict the character and extent of biochemical reactions that may cause harm, together with the reactions fostering protection and recovery, not only would toxicological observations be most usefully supplemented, but uncertainties of analytical procedure might also be clarified. The first step would be to ascertain the route and fate of the ingested food additive. This may seem elementary, but such approach has too often been ignored or has been given but scant consideration. Application of the biochemical approach in the study of pesticides that inhibit cholinesterase activity furnishes a relatively recent and encouraging example of its value. At feeding levels much below those resulting in minimal tissue abnormality, these substances have been shown to lower, drastically, the activity of the important body enzyme, cholinesterase. Techniques by which this more delicate index of their harm was established have been adapted to methods of measuring the concentrations of their residues.

Some verbally resourceful investigator, seeking to explain the unexplainable, invented the term "subclinical symptoms." We are indebted to him for expression of a concept pertinent to food safety problems. The specter of as yet unmanifested harm from food additives may

not safely be laid to rest in routine fashion; and it may become a quite personal threat. Most of us have children; some have dependent invalids; many have grandparents; and all may hope to join the ranks of elder citizens. For any of these the ghost of subclinical symptoms may materialize, with tragic consequence, unless understanding of effects of food additives can keep pace with their increasing usage.

Another of the food additive problems, one that is virtually untouched by investigation, concerns the number and variety of the substances in use. In the aggregate they represent almost infinite possibilities for combinations of novel substances in the human diet. It seems hardly conceivable that there would not be some in which the effect of combined toxicants would be not only additive but synergistic.

Obviously, progress in exploring this problem by hit or miss testing of each possible combination, in a sufficient range of relative proportion, could be far beyond any foreseeable resources. However, improved understanding of biochemical reactions might go far in expediting useful findings. At least some examples of the phenomenon of synergism may reflect only associated biochemical reactions in which one agent reacts to produce the primary harm, while another impedes normal resistance or recovery mechanism. If this be even a rough explanation of synergism, quite unanticipated consequences could arise from combinations of toxicants, each present at a level which by itself would warrant no concern.

Cold Sterilization

It would hardly be possible, these days, to discuss food-safety problems without bringing to mind those that could conceivably stem from what many informed food technologists believe to be a promising application of atomic energy, that is, so-called cold sterilization. This is accomplished by exposure of food to ionizing rays, either gamma rays, which are not basically different from the more familiar X-rays, or beta rays, which are simply fast-moving electrons. Nothing of significant substance is added to the food so processed; energy alone is imparted to it. Energy in this form produces in organic matter the effect of ionization. Ionization is a molecular change that increases chemical reactivity. Consequently, chemical reactions occur in food as a secondary result of its irradiation. One product of such reactions is peroxide, not only the simple and familiar hydrogen peroxide but peroxides of other kinds, perhaps including those of most complex molecular structure. There is yet no assurance, and it is theoretically improbable, that reactions occurring are solely those producing peroxides. On the contrary, at this stage it appears more likely that the induced reactions are substantially heterogeneous rather than specific.

We disclaim any special knowledge in this area. Although the Food and Drug Administration has not hesitated to cooperate in an advisory capacity on questions within its competence, its responsibilities do not ordinarily extend to active participation in development of new processes. But new processes for food invariably pose potential food safety problems, and, accordingly, the agency always has been an interested observer of such developments.

We were reasonably well assured quite early, from information we received, that there was very remote possibility, if any, of inducing radioactivity in food by exposing it to such levels of radiant energy as are at all likely to become available, or even practicable, for such use. There has been no serious proposal whatever for the direct addition of radioisotopes to food. Radioisotopes, if used in cold sterilization, would be used solely as sources of radiant energy. Actually, at least some investigators of cold sterilization appear to favor mechanical generation of the energy, as more practical than deriving it from radioisotopes. There is room for appropriate concern, of course, that disposal of atomic wastes could result in contamination of water supplies and thereby introduce a threat to safety of the diet. Precautions so far taken, and realistically to be expected, appear to foreclose any immediate prospect of food hazard from such source. However, it will take constant vigilance to maintain that satisfactory situation.

Development of cold sterilization thus far has shown no essentially new or mysterious type of food safety problem. The energy, the application of it, and the mechanism of its

FDA inspector collecting import sample of meal at pier.

effect are new; but the end result seems to be of a quite familiar nature—the appearance in food of new and largely unknown chemical substances. Although probably much more complex, the problem seems basically of the same kind as those stemming from use of new chemical adjuvants in food production.

Radiant energy holds promise of production practicability for such objectives as preventing the sprouting of potatoes, killing trichina organisms in pork and insects infesting grain, pasteurizing a variety of foods sufficiently to extend their life very substantially without refrigeration, and retaining prominent elements of freshness in meat and other commodities.

Energy requirements for accomplishing these purposes vary. Sprouting of potatoes, for example, is inhibited at relatively low energy input; sterilization of micro-organisms generally requires almost 10 times as much. As energy requirements increase, so do unfavorable side effects. The process is not promising for milk, for example, because of disagreeable flavor changes produced by energy input far lower than enough to pasteurize. Nutrient values are also affected at energy input sufficient to sterilize. Vitamins A, thiamine, riboflavin, pyridoxine, B_{12}, ascorbic acid, and niacin are destroyed in varying degree, and some alteration in nutritive value of protein has been observed.

The observed organoleptic and nutrient changes in products subjected to cold sterilization confirm that expected chemical reactions do take place. They signify the possibility, if not the probability, of a wide variety of reactions and, hence, a wide variety of end products. Common prudence dictates a concern as to the identity of such end products. These are food additives, for all practical purposes. Good practice in toxicological investigation involves

feeding of experimental animals at a high level of a proposed food additive, with the objective of discovering the nature of definable injury, a middle level which may or may not give evidence of injury, and a lower level which does not affect the animal. The data so obtained permit an estimate of the margin of safety of the additive in use. Sole reliance on findings of orthodox toxicological study of irradiated foods themselves, in ignorance of both the identity and quantity of substances therein that may influence such findings, invites valid reservations to any final conclusions.

It can hardly be overemphasized that the problem of appraising the safety of cold sterilization is complex, of wide scope, and demanding of very considerable investigative resources. A great deal of work has been done on it, and significant progress has been made. It does not appear, however, that the safety of the process is anything like as near being established as is its production practicability.

Antibiotics as Adjuvants

One class of potential food production adjuvants that does not currently constitute a problem in the same sense as the others discussed is the antibiotics. We have a sufficient gauge of their deleterious properties to conclude that, in food as consumed, their presence in virtually any concentration whatever is unjustified.

The wide and valuable usage of antibiotics in medicine is well known. The reasons for their curative efficacy are precisely the reasons that make them effective preservatives: They combat development of bacteria, the prime cause of food spoilage. It is not so generally appreciated that their medical usage is attended by distinct hazard of sensitization, varying in degree with different antibiotics. To the individual who is or has become sensitized, administration of an antibiotic may cause serious illness or even death. A method of developing sensitization is by administering the agent in small repeated dosage, in a manner paralleling that of repeatedly ingesting food preserved with an antibiotic. The use of antibiotics as food production adjuvants in ways such that they actually are consumed is therefore manifestly contrary to the public interest, and the Food and Drug Administration has formally so declared.

However, there are a few justifiable uses of antibiotics in food production or processing. For example, it has been shown that fresh dressed chicken cooled in ice water containing 10 p.p.m. chlortetracycline will not absorb more than 7 p.p.m. of the antibiotic in any portion of the flesh, and that more than 99 percent of this pickup will be destroyed by any type of cooking sufficient to make the chicken suitable for consumption. The cooked treated chicken exhibits antibiotic activity no greater than that of untreated chicken. On this evidence, a tolerance of 7 p.p.m. of chlortetracycline, not to be exceeded in any part of the flesh, has been established for raw chicken.

Conceivably, there may be other, equally safe, food uses of antibiotics, but they would need to be equally well supported by fact in each case. It seems improbable, at this time, that many such instances could arise.

Summary

Chemical additives, whether they be intentionally put into food or the incidental result of food production or processing procedures, are today the major cause for concern with respect to the safety of food. And it is the uncertainty surrounding these substances and their effects rather than any knowledge of actual harm that is the main reason for concern. In particular: What are the effects on persons with physical impairments? What are the effects of the multitude of combinations of the many substances in use?

In discussing any problem without at the same time describing measures taken toward its solution, or ancillary controls in effect pending final solution, it is difficult to avoid exaggerating the immediacy of evils the problem may involve. We have no wish to be alarmists. Our purpose has been to examine objectively some of the elements of needed knowledge that would contribute to understanding food safety problems.